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BEETLE POLLINATION IN DRACUNCULUS AND SAUROMATUM (ARACEAE)

By Bastiaan J. D. Meeuse *and* Melville H. Hatch[1]

The famous Lamarck, in 1777, was the first to draw attention to the development of considerable heat in the inflorescences of certain arum lilies (3). This phenomenon, which can lead to a difference in temperature with the environment of about 20° C, is accompanied by the production of a pronounced odor, different from species to species but usually carrion-like. A truly classical demonstration of its biological significance was given in 1926 by Knoll (1). For the two European species, *Arum maculatum* and *Arum italicum*, he could show that the odor serves the purpose of attracting large numbers of small insects—mostly Psychodid flies, but also some Staphylinid beetles—which are thereupon trapped in the floral chamber where they are held prisoner for about a day. Since the pistillate or female flowers at the base of the floral column are the first ones to reach maturity, and since some of the visitors may have come from other Arum inflorescences that were in the process of shedding their pollen, the likelihood of cross-pollination is great. The staminate or male flowers, grouped together in the region just above the female flowers, do not shower the captive insects with their pollen until a short time before the moment when certain wilting phenomena make escape from the trap possible. An insect-attracting function of the heat could not be demonstrated; its main (or perhaps even its exclusive) role may well be the volatilization of the odoriferous substances.

Predominant carrion beetle pollination has been described by Van der Pijl (5) for a number of Amorphophallus species, including the giant *Amorphophallus titanum*, in the East Indies; by Schmucker (4) for *Dra-*

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cunculus creticus on the island of Crete; and finally by Kullenberg (2) for *Arum dioscoridis* in Lebanon. In many regions of the United States, an excellent opportunity to observe beetle pollination is provided by the circumstance that the so–called dragon lily, black calla, or black lily of the Nile, *Dracunculus vulgaris* Schott, is a popular garden plant. In spite of the fact that it stems from the northern Mediterranean region (Portugal to western Asia Minor), it is very successful in Seattle, where its inflorefcences will as a rule begin to unfold around the middle of June. Although these blooms are on the average about two feet tall, they occasionally grow to a height of three feet. The inside of the "spathe" is of a very deep purple color, while the sterile part of the central column (the so-called appendix) has the dark and glossy appearance of black cherries. It is this appendix which is responsible for the smell, produced in the morning hours of the opening day and strongly reminiscent of long dead–half dried fish. More specifically, there is a resemblance between the odor of Dracunculus and that of pedah, a fish product used on a large scale for human consumption in the East Indies and Siam (Van Veen 7). Although carrion and dung flies such as Calliphora, Lucilia and Sarcophaga are attracted in a matter of minutes and can be observed buzzing around the fresh inflorescences and sitting on the appendix, where they may even deposit their eggs, they do not as a rule assemble in the floral chamber. Carrion and dung *beètles*, on the other hand, will accumulate here in large numbers. Thus, in one instance, 162 beetles were obtained from a single Dracunculus inflorescence by cutting it off in the middle of the afternoon of its first flowering day. If the inflorescences are allowed to remain in their natural position overnight, only a few beetles are found in them the next morning. However, the present authors have never consistently followed the change in beetle population with time for one single Dracunculus inflorescence. By the next morning the carrion smell has given way to a very faint aromatic and not completely unpleasant odor, somewhat reminiscent of that produced by certain Papilio caterpillars when they stick out their scent forks. The flowering sequence, ensuring cross pollination, is essentially the same as that described for *Arum maculatum* and *Arum italicum*; i.e., the inflorescence is proterogynous, the female flowers are receptive before the male flowers in the same inflorescence begin to shed their pollen.

With one exception (a collection made in the garden of a private home in Seattle) the following observations all pertain to a single collecting site on the campus of the University of Washington behind the new Botany Greenhouse. All but one of the inflorescences here were produced by two large clumps of *Dracunculus vulgaris*. The inflorescence that formed the exception was brought in from a private garden and left amid the foliage

of one of these clumps. Over a period of 7 days (June 18 to 24) 298 beetles were collected, as follows. The number of specimens taken and the normal habitat of each species is indicated in parentheses.

HYDROPHILIDAE: *Cercyon pygmaeus* Ill. (1, dung).

SILPHIDAE: *Silpha lapponica* Hbst. (1, carrion)

STAPHYLINIDAE: *Platystethus americanus* Er. (4, dung), *Aleochara bimaculata* L. (1, dung), Aleochara gen. et sp. undet. (1), *Philonthus pachycephalus* Nord. (2, carrion), *Philonthus politus* L. (1, carrion).

HISTERIDAE: *Saprinus oregonensis* J. LeC. (207, carrion), *Saprinus lugens* Er. (57, carrion), *Margarinotus umbrosus* Csy. (1, carrion).

DERMESTIDAE: *Dermestes frischii* Kug. (3, carrion).

NITIDULIDAE: *Nitidula carnaria* Schall. (13, carrion), *Omosita colon* L. (4, carrion).

LATHRIDIIDAE: *Melanophthalma distinguenda* Com. (1, compost).

CRYPTOPHAGIDAE: *Anchicera ochracea* Zimm. (1, compost).

It is not without interest to compare this list with the one given by Schmucker (4) for *Dracunculus creticus*, a plant usually considered to be just a variety of *Dracunculus vulgaris*. With four exceptions the species reported are normally found on carrion and dung. The two Mycetoporus spp. occur in moist moss, among fallen leaves, under stones, etc. The species of Carpophilus occur under bark, at sap, and in warehouses.
Malthodes is found on vegetation.

HYDROPHILIDAE: *Cercyon haemorrhoidalis* F.

STAPHYLINIDAE: *Oxytelus complanatus* Er. (22), *O. sculpturatus* Grav. (5), *O. inustus* Grav. (2). *Mycetoporus reichei* Pand. (7), *M. piceolus* Rey (1), *Aleochara* sp. (1), *Atheta* sp. (1), *Philonthus sordidus* Grav. (1), *P. longicornis* Steph. (1), *Xantholinus rufipennis* Er. (1).

HISTERIDAE: *Saprinus semistriatus* Scriba (1), *Saprinus* sp. (1).

CANTHARIDAE: *Malthodes* sp. (1).

DERMESTIDAE: *Dermestes frischii* Kugel. (9).

NITIDULIDAE: *Carpophilus immaculatus* Luc. (1).

It can be seen that some of the genera and one of the species observed on the island of Crete and in Seattle are the same. Moreover, a second species, *Cercyon haemorrhoidalis* F., is likewise recorded below from the inflorescence of *Sauromatum guttatum* in Seattle.

From the Lebanese arum lily, *Arum dioscoridis*, Kullenberg (2) has reported the following beetles, most of which are likewise normally found on dung or carrion.

HYDROPHILIDAE: *Cercyon haemorrhoidalis* F. var. *discoidalis* J. Sahlb.

STAPHYLINIDAE: *Oxytelus sculpturatus* Grav., *Philonthus intermedius* Boisd.

SCARABAEIDAE: *Onthophagus ovatus* L., *O.* ? *sellatus* Kl., *Aphodius signifer* Muls. & Rey, *Oxyomus silvestris* Scop.

These Coleoptera were accompanied by the dung flies (Diptera) *Scatophaga stercoraria* L. and *S. maculipes* Zett.

From the above it is clear that access to Arum lilies such as Dracunculus and *Arum dioscoridis* makes it possible for the beetle collector to obtain large numbers of certain carrion and dung beetles in a most elegant and painless way. It is one of the purposes of the present paper to draw attention to this fact and to enlist the cooperation of coleopterists in the study of Arum lilies. The scientific value of lists of beetles visiting these flowers obviously transcends their taxonomic significance. A comparative analysis of the "visitor spectrum" for species differing in odor will undoubtedly lead to more precise information on the exact ecological niche which each species of carrion or dung beetle occupies. Ideally, a complete chemical analysis of the odoriferous substances should be carried out for each species of Arum lily involved, and eventually this may lead to attempts to attract the beetles with well defined mixtures of the pure chemicals. This is an ambitious and optimistic program, in which, however, the human nose, fallible though it is, may give some guidance. Thus, there is at least a chance that the similarity in smell between the appendix of Dracunculus and the fish product, pedah, is not fortuitous but is due to the presence of the same chemical substances. A partial analysis of the pedah odor has been carried out (Van Veen 1941). On the basis of this, one or more of the following substances may be expected to be produced by the Dracunculus appendix: ammonia, trimethylamine, other methylamines, volatile fatty acids, methylnonylketone, butylaldehyde, some highly unsaturated aldehydes, and traces of sulfur compounds.

The present authors were fortunate in having available a number of inflorescences of *Sauromatum guttatum* Schott, a native of northwest India and Pakistan, producing a smell which, although carrion–like, is decidedly different in character from that of Dracunculus. Just as in Dracunculus, the odor in Sauromatum is developed in the morning hours. The inflorescences were exposed to insects in the same locality as the Dracunculus. Unfortunately, they appeared later than the Dracunculus blooms, so that in only one case simultaneous exposure of the two types could be practiced. Yet it is believed that the observed difference in the visitor-spectrum between Dracunculus and Sauromatum is significant. The latter accumulates flies along with beetles in the floral chamber. In the greenhouse, where one of us (B.J.D.M.) has made observations on hun-

dreds of Sauromatums over a period of several years, flies are successful pollinators. However, they are the only insects present there. No information is available on the pollination in Sauromatum's native habitat. It is tempting to assume that beetles are responsible for it. The yellow, club-shaped and decidedly fleshy "hairs" which are found in the inflorescence instead of the bristles present in many other Arum lilies may well serve as nutritive tissue for the beetles. The following is a list of the beetles collected in Seattle on the freely exposed Sauromatums over the period June 24 to July 29.

HYDROPHILIDAE: *Cercyon haemorrhoidalis* F. (4, dung).
STAPHYLINIDAE: *Platystethus americanus* Er. (14, dung). *Aleochara bimaculata* Grav. (4, dung), Aleocharinae gen. et sp. undet. (1).
HISTERIDAE: *Saprinus oregonensis* J. LeC. (22, carrion).
NITIDULIDAE: *Glischrochilus 4-signatus* Say (2, sap and fermenting fruit).

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BARK- AND TIMBER BEETLES FROM THE NEOTROPICAL REGION

By Karl E. Schedl [1]

173. Contribution to the morphology and taxonomy of the Scolytoidea

During recent years I have examined quite a number of Scolytidae and Platypodidae from the neotropical region, some larger ones from the Californian Academy of Sciences forwarded by the Curator Hugh

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